

# Chapter 1 I-5 Marysville Cable Barrier Evaluation

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Over the last 10 years, WSDOT's efforts to improve highway safety have included engineering to help drivers keep their cars on the road and to lessen the safety consequences when they fail to do so. We have installed rumble strips, improved and straightened curves, widened highway shoulders, improved medians and installed median barriers.

In Snohomish County, for example, when State Route 525 in Lynnwood and State Route 522 near Maltby were rebuilt, medians and median barriers were installed on the new divided highways. We installed shoulder rumble strips on all of I-5 in Snohomish County. We installed raised medians on urban arterials, including State Route 525 in Mukilteo and State Route 527 in Mill Creek. Our efforts to help keep drivers on highways produced dramatic results. From 2002 through 2004 fatal highway collisions in Snohomish County decreased 50 percent and fatal head-on collisions dropped 75 percent.

Despite the good results found across the county, the public has raised concerns about I-5 in Marysville resulting from the increasing number of crashes and the number of crossover collisions. As a result, WSDOT conducted a comprehensive review of traffic safety on I-5 through Marysville.

The purpose of this evaluation was to examine crashes that went through cable median barrier on I-5 in Marysville, so whenever practicable we included the five vehicles that crossed through cable median barrier in 2005. However, most other 2005 collision and traffic data is not yet available. As a result, some parts of this evaluation must rely upon data from 1999 through 2004.

## 1 About I-5 through Marysville

The section of I-5 between State Route 528 and the Stillaguamish River is a six-lane divided highway. The northbound and southbound lanes are separated from each other by a median, primarily 40 feet in width, with one section approaching 80 feet wide near the Stillaguamish River. There are seven undercrossing and four overcrossing bridges.

Freeway ramps are located at the rest area and at five interchanges located at State Route 528, 88<sup>th</sup> Street NE, 116<sup>th</sup> Street NE, State Route 531, and State Route 530. The roadway traverses generally flat or rolling terrain and crosses both Quilceda Creek and Portage Creek.

### Cable barrier

9.08 miles of median on this 10.13 mile long stretch of I-5 has cable median barrier. WSDOT installed cable barrier within this area during two different highway improvement projects.

Crews installed 2.12 miles of median cable barrier as part of the first project in November of 1995. This barrier was located near the 116<sup>th</sup> Street interchange, between milepost 201.38 and milepost 203.70. It was located approximately 11 feet west of the northbound median edge line.

Figure 1-1  
I-5 Marysville



Crews installed approximately 9.08 miles of median cable barrier as part of the second project in February 2000. Crews removed the existing median cable barrier and reinstalled it closer to the bottom of the median ditch. This was done to move the barrier farther away from traffic to reduce the chance of impact with the barrier and subsequent risk of injury. It also provided a more balanced area for barrier deflection between the two directions of travel. In addition, crews installed approximately seven miles of new median cable barrier between State Route 528 and the Stillaguamish River, from milepost 199.16 to milepost 209.30.

#### **Other median barrier**

There are other areas within this highway segment that have beam guardrail, bridge rail, earth berms and precast Jersey barrier in the median. Typically, these barriers were used where there is insufficient room to provide the deflection distance required by cable barrier. Combined, these areas total 1.07 miles and overlap with cable barrier in some locations.

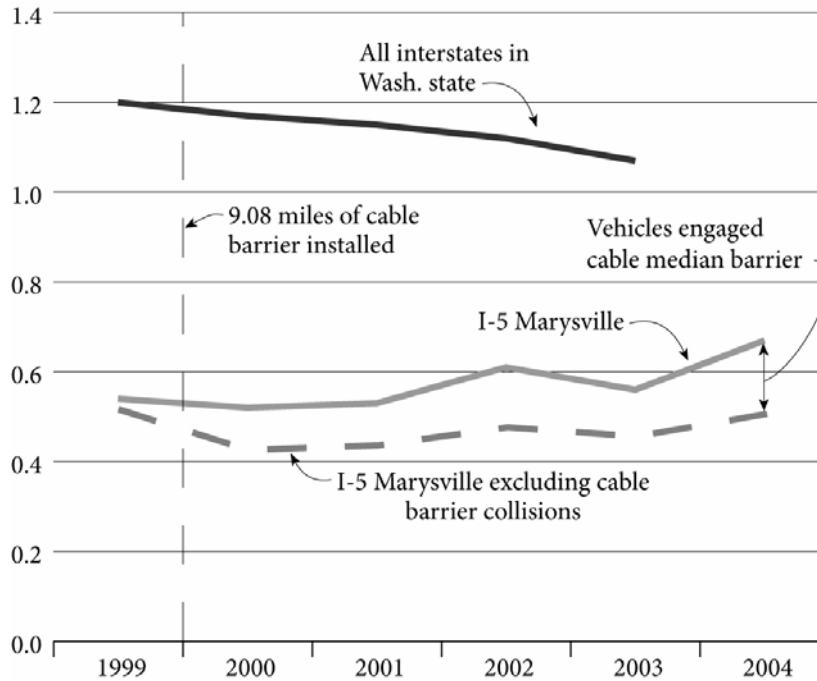
## **2 Are there more collisions on I-5 in Marysville than other interstate highways?**

No, there are fewer collisions on I-5 in Marysville than other interstate highways in Washington State, though the number of collisions is increasing in Marysville.

WSDOT reviewed six-years of collision data on a 10.13 mile stretch of I-5 through Marysville from 1999 through 2004. During this time there were 995 collisions; 715 occurred on the freeway and 280 occurred on the on- and off-ramps. The number of collisions on this stretch of I-5 has grown in the last several years, from 99 in 1999 to 149 in 2004.

A good way to compare highway collision data is to use collision rates per million vehicle miles traveled. This allows a fair comparison between highways that carry different volumes of traffic. This method of comparison reveals that the collision rate for I-5 in Marysville is trending upward while the rate for other interstate highways in Washington State is trending downward.

**Figure 1-2**  
**Freeway Collision Rates**



*Average collision rate per million vehicle miles (including ramps).*

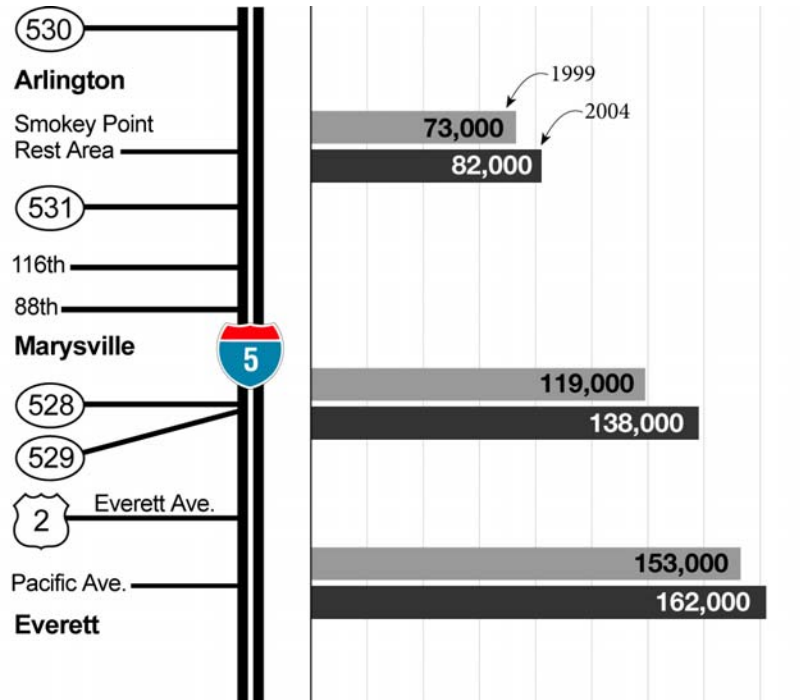
This increasing collision rate is typical of freeways where traffic congestion is increasing. Speeding drivers and recently installed barrier also contribute to the increase in reported collisions.

### Traffic growth

Traffic on I-5 from Everett through Arlington grew rapidly over the past five years.

Exhibit 1-3

### I-5 Average Daily Traffic Count



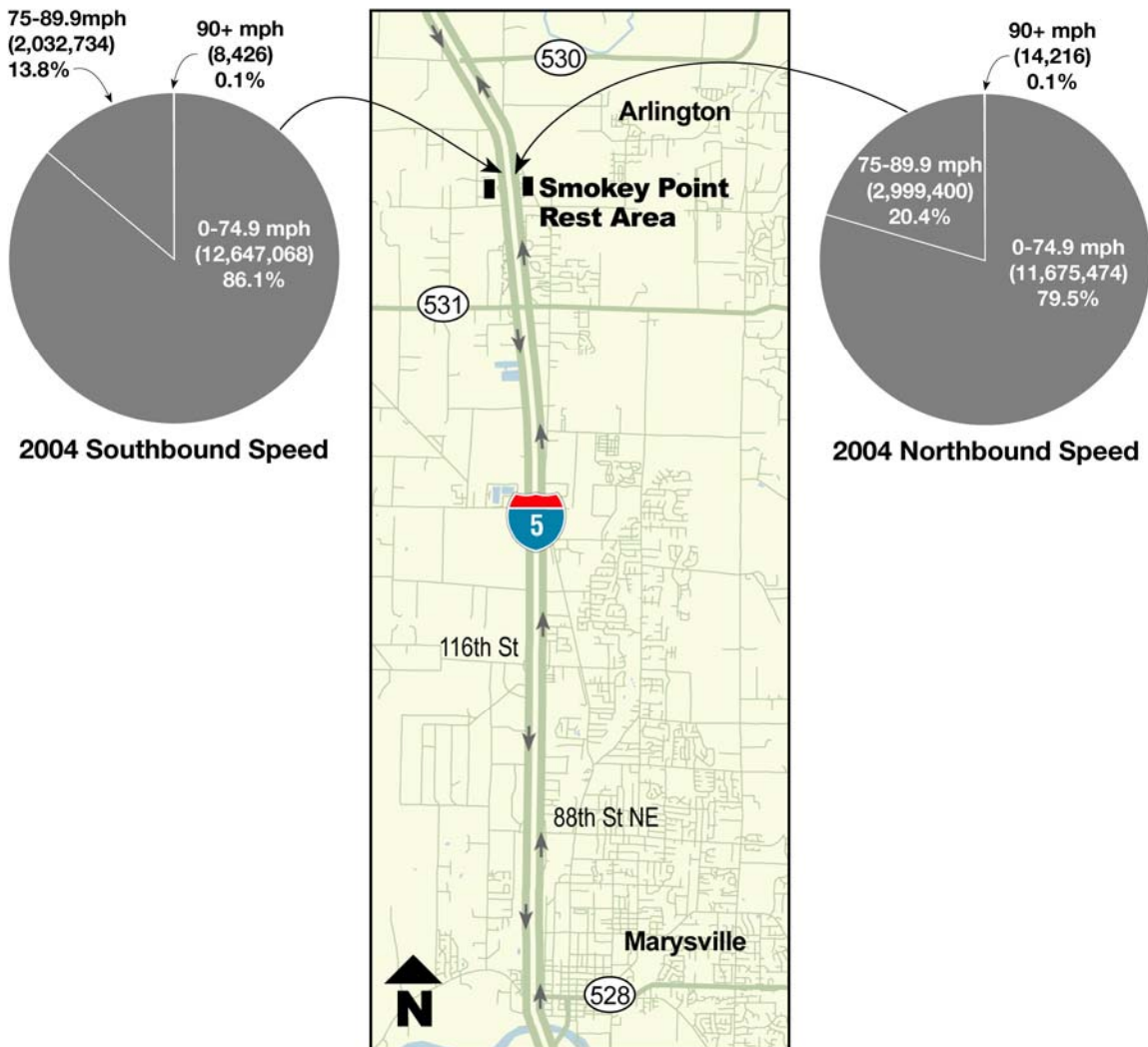
*I-5 traffic counts for three locations: the Snokey Point Rest Area, State Route 528 and Pacific Avenue in Everett. Counts indicate the average number of vehicles per day on the road in both directions.*

### Traffic speeds

In 2004, an average of 62 drivers per day exceeded 90 mph on I-5, north of the Smokey Point Rest Area. This was one of the places in the state where drivers most frequently traveled at 90 mph or faster. While the percentage of drivers traveling at these high speeds is very small, data indicates that a high number of motorists are driving recklessly. Other drivers on I-5 in Marysville were speeding, too. Fourteen percent of southbound drivers and 20 percent of northbound drivers were traveling at 75 mph or faster. The speed limit was 70 mph until June 30, 2005.

Exhibit 1-4

### I-5 Marysville Traffic Speeds



On July 1, 2005, WSDOT reduced the speed limit on I-5 through Marysville from 70 mph to 60 mph between just north of downtown Marysville to just north of the 172nd Street NE interchange in Smokey Point. Traffic speeds have since declined both in terms of the average as well as the speed that the preponderance of drivers travel at (85<sup>th</sup> percentile).

Exhibit 1-5

### Southbound Traffic Speed Trend, I-5 Marysville, 2005

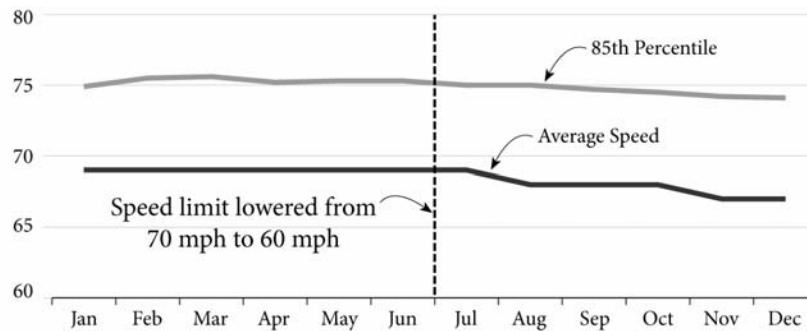
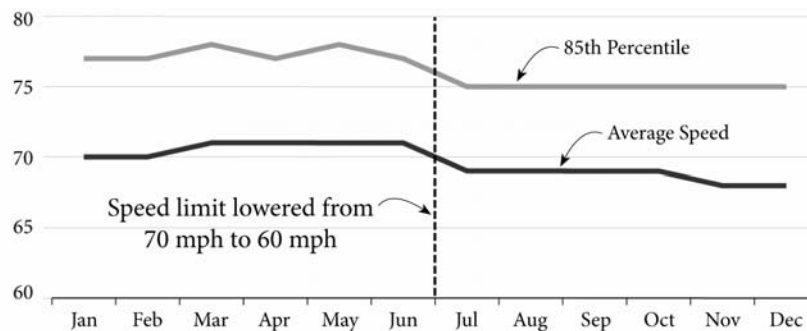


Exhibit 1-6

### Northbound Traffic Speed Trend, I-5 Marysville, 2005



### Mixing congestion and speed increases risk

When speeding vehicles encounter traffic congestion, some drivers abruptly slow down or weave through slower moving traffic. This increases the risk of collision and the likelihood of drivers losing control and running off the road. The mix of congestion and speed occurs on I-5 through Marysville.

Northbound drivers on I-5 in Marysville often emerge from traffic congestion at State Route 531 and the Smokey Point Rest Area. Some of these drivers then accelerate to high speeds. Southbound drivers on I-5 often enjoy free-flowing traffic until they reach State Route 531, where they encounter an urban setting with heavier traffic. There they encounter more merging, lane changing, and congestion.

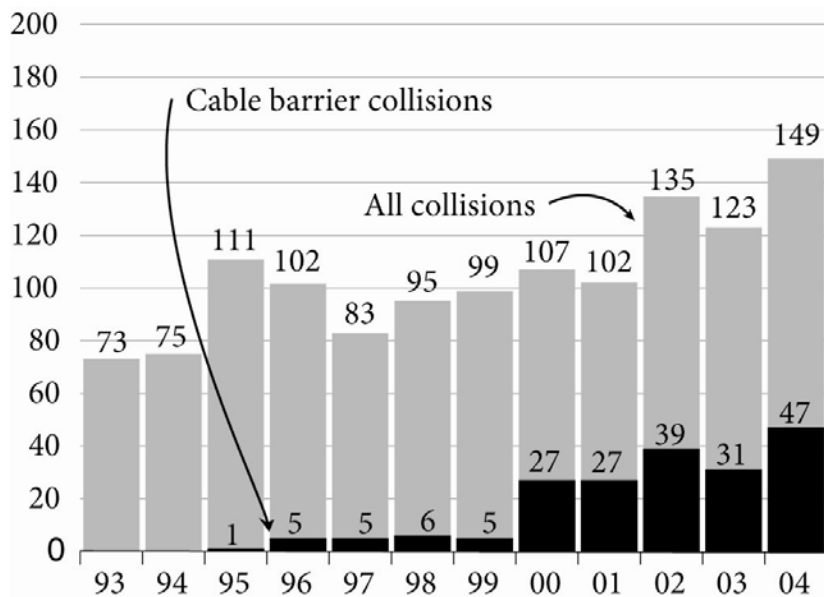
### Collisions increase after barrier installation

During the past five years the collision rate for I-5 in Marysville has increased 27 percent. If you exclude collisions with cable median barrier, the overall collision rate on I-5 in Marysville has increased 19 percent.

The increase in recorded collisions is in part due to the cable barrier installation. Before the cable barrier was installed, vehicles that went into the median and recovered were not logged as collisions. After the barrier was installed, many vehicles that went into the median struck the barrier and were subsequently logged as collisions.

Exhibit 1-7

### Collisions and Cable Barrier Collisions, I-5 Marysville

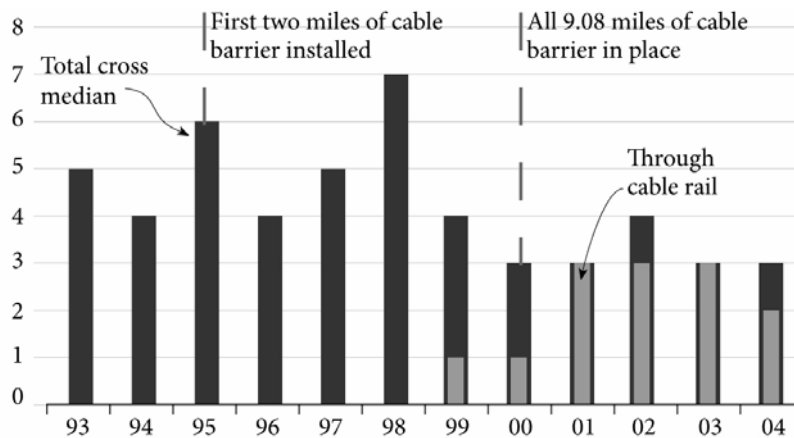




While more vehicles are entering the median, the total number of vehicles that have crossed the I-5 median in Marysville have declined since we installed 2.12 miles of cable median barrier in 1995 and 9.08 miles in 2000. The number of cross median collisions remains steady at three to five per year. The cable barrier is catching 92.4 percent of errant vehicles. Most of the cross median crashes since the cable barrier was installed in 2000 involved vehicles traveling through cable barrier. Five vehicles traveled through cable barrier in 2005. Total cross median collision data for 2005 is not yet available.

Exhibit 1-8

### Cross Median Collisions, I-5 Marysville



### 3 Are there more through- barrier crashes on I-5 in Marysville than elsewhere?

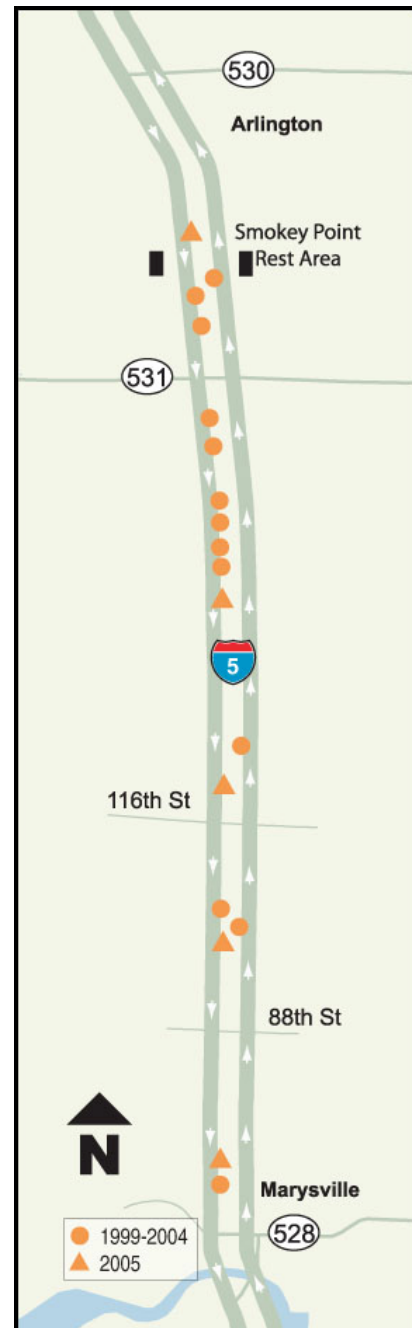
Yes. When a vehicle hits cable barrier on I-5 in Marysville it is more likely to go through the barrier than in other locations with cable barrier.

On I-5 in Marysville, 171 collisions that struck cable barrier were reported to the Washington State Patrol from 1999 through 2004. Thirteen (7.6 percent) of these collisions crossed the median into the opposing lane of traffic. The rest of the state averages 5 percent.

The rate at which errant vehicles go through cable barrier in Marysville (0.11 crossovers per billion vehicle miles traveled) is higher than I-5 at Fife (0.07 crossovers per billion vehicle miles traveled) and at Vancouver (0.01 crossovers per billion vehicle miles traveled). Even though it has the lowest freeway crash rate; roughly similar traffic congestion, weather and geometric conditions, Marysville has the highest rate of vehicles hitting median barrier and the highest cross median crash rate.

WSDOT researched cable barrier performance in eight other states. We found that through-barrier crash rates for cable barrier range from one to 21 percent in the five states that could provide reasonably accurate data (New York, North Carolina, South Carolina, Utah and Oregon). In all these states, the average severity of collisions and the number of cross median collisions decreased after installation of the cable barrier.

Figure 1-9  
I-5 Marysville Cross  
Median Crashes, 1999  
through 2005



#### 4 Why are more through- barrier crashes occurring on I-5 in Marysville?

Our research revealed that 15 of 18 vehicles (83%) that crossed the median on I-5 in Marysville from 1999 through 2005 were traveling in the southbound direction. This was even more notable because southbound vehicles in this area comprised only 46 percent of all cable rail collisions between 1999 through 2004. All three crossover collisions that resulted in fatalities involved southbound vehicles. This led us to focus our research on southbound crossover collisions.

When we examined the 15 southbound crossover collisions, we determined that 11 involved sedans. This led us to focus our research on collisions involving sedans.

We then examined the locations where southbound sedans crossed the median. We found that all 11 of these crossover collisions occurred where the cable barrier was placed within five feet of the bottom of the ditch on the slope nearest the northbound lanes.

**Exhibit 1-11**  
**Crossover Collision Factors**

	Southbound	Northbound	Total number of collisions	Years
Hits on cable median barrier	78 (46%)	93 (54%)	171	1999-2004*
Cable barrier crossovers	15 (83%)	3 (17%)	18	1999-2005
Sedan crossovers	11 (73%)			1999-2005
Sedan crossovers where cable is within 0' to 5' of ditch	11 (100%)			1999-2005

*2005 cable barrier hits data not yet available*

**Exhibit 1-10**  
**Car Lifting Cable Barrier**



*This photo, from a Federal Highway Administration crash test, shows how the front tires of a sedan compress after hitting the bottom of a ditch. This allows the bumper of the car to nudge under the lowest barrier cable.*



*As the vehicle continues forward it lifts the cable median barrier and continues up the slope, while the cables pass over the top of the vehicle.*

This data, along with collision and maintenance reports, overwhelmingly suggest that southbound sedans ran into the median and bottomed out in the ditch. This compressed the cars' front tires, which left their front bumpers low enough to nudge beneath the lowest cable on the barrier. As momentum carried the cars up the slope, they lifted the cable median barrier and continued across the median as the cables passed over the top of the vehicle. This accounts for a preponderance of the cross median collisions near Marysville.

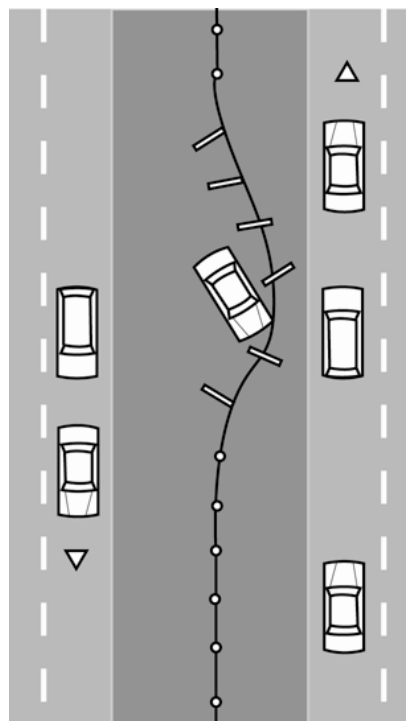
### Deflection

There were also instances where the cable rail exceeded the deflection needed to contain the vehicle in the median, however the cables still caught the vehicle. In these cases the vehicle encroached partially into the oncoming lane. From 1999 through 2005, three of 18 cross cable rail crashes involved cable rail acting in this manner, and in all of these instances the cable barrier still prevented a more serious head on collision from occurring. Many of the collisions involved extremely high speeds and angles of collision.

### Slope

Generally the roadway median is shaped like a shallow ditch. Guidelines for cable barrier recommend installation on slopes that are 6H:1V or flatter. This slope ratio indicates that for every six feet of horizontal distance the ground drops one foot vertically. On slightly more than 12 percent of I-5 through Marysville the median slopes are steeper than 6H:1V. Three (18 %) of the cross median crashes occurred where a portion of the slopes were steeper than 6H:1V. Because the number of incidents occurring at a steeper slope is low, the effect of the slopes on the cross median crashes is inconclusive.

**Figure 1-12**  
**Cable Barrier Deflecting During Impact**



*Cable barrier is designed to flex and absorb the force of impact when struck while still keeping an errant vehicle within the median.*

## **5 What other factors did we examine?**

### **Curves**

There is one significant horizontal curve within the stretch of I-5 near the Smokey Point Rest Area between milepost 207.74 and milepost 208.02. This curve has a combination of earth berms, precast Jersey barriers and beam guardrails. We examined the collision locations and found no evidence that the curve played a factor in cable barrier crossover collisions.

### **Anchor locations**

There are 60 cable barrier anchors within this section of roadway holding down 30 individual cable barrier runs.

Design guidelines allow for a maximum of 2,000 feet between cable barrier anchors. In this section, the shortest cable barrier length is 582 feet and the longest is 1959 feet. All of the cable barrier lengths are within design standards.

We compared known accident locations and their proximity to cable barrier anchors. We could find no evidence that the accident distance from a cable barrier anchor played any role in cross median collisions.

### **Cable height**

The height of cable barrier as measured between the ground and the top cable is specified as 30 inches. We measured the cable heights on all cable runs during our recent roadway survey. We found that 80 percent of the cable was within 1" of the plan cable height, and 95 percent of the cable was within 2" of the plan height. When we compared cable heights at known accident locations, we found that the cable height does not appear to be a factor in any of the cross median collisions.

## **6 What are we going to do to address cross median collisions on I-5 in Marysville?**

### **Install a second run of cable median barrier**

In 2006, WSDOT will install a second run of cable barrier in the I-5 median in Marysville. We decided to add a second run of cable barrier because it should reduce the risk of serious injury to people in vehicles that hit it compared to the other alternatives while also stopping vehicles from crossing through the barrier into oncoming traffic. We evaluated a broad array of options, including concrete barrier and guardrail in multiple configurations. These options would increase the number and severity of crashes overall (for more information regarding injuries involved with different barrier types, see Chapter 2).

The new high tension cable barrier will be closer to the southbound shoulder, approximately twelve feet from the fog stripe on the opposite side of the median from the current cable barrier. It will deflect less than the current cable barrier. Because errant vehicles in both the southbound and northbound directions will engage a cable barrier before running into the bottom of the median ditch, this should significantly reduce and perhaps eliminate the possibility that vehicles could go under the cable barrier since they will already have engaged the cable barrier before bottoming out in the ditch. It should also control the risk of collisions due to the cable deflecting cars into oncoming traffic lanes. Also, as part of the new project, all locations where the median slopes are currently steeper than 6H:1V will be modified to provide a flatter slope.

Placing cable barrier on both sides of the median ditch provides a redundant system to control the chance of cross median collisions.

**Reduced speed limits and continued speed limit enforcement**

In 2005, WSDOT reduced speed limits from 70 mph to 60 mph on the most congested part of I-5 through Marysville.

Washington State Patrol troopers have been conducting emphasis patrols to enforce the new speed limit. These efforts are making a difference. During the second quarter of 2005, with a 70 mph speed limit, 18.4 percent of all drivers traveled above 75 mph. During the third quarter of 2005, after the speed limit was lowered to 60 mph, 13.2 percent of all drivers traveled above 75 mph. In addition, the number of drivers traveling at speeds above 90 mph near the Smokey Point rest area dropped 20.5 percent, from an average of 78 drivers per day to 62 drivers per day during the six-month study period.

The Washington State Patrol plans to continue its efforts to enforce speed limits and aggressive and negligent driving laws in this area.